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SHOCK COMPRESSION OF $ZrSiO_4$ AND METAMICT DECAY[1]

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One of the main effects observed in silicates affected by shock waves is their conversion to a radioamorphous glassy state. This conversion was observed for SiO_2 [1-5], $CaAl_2Si_2O_6$ [6], $NaAlSi_3O_8$ and $MgSiO_3$ [7] both when a plane wave was passed through a single crystal [1, 2] and polycrystalline matter [4-6] and when powder was pressed into cylindrical ampoules [3, 7]. Clarification of the essence of this conversion is of great importance for understanding the processes in solid phases affected by shock waves and for determining the potential of phase transitions in silicates. This is considered in the present work.

The change to a vitreous state may result from distintegration during passage of the shock wave (which is irrefutable for a plane wave in single crystals of SiO_2 [1, 2]), although it can be interpreted in many cases as simple fusion under the action of the high temperatures persisting for some time after the shock wave has passed. The latter assumption can be expressed, in particular, for powder pressed into cylindrical ampoules. Certain indirect facts, in particular the formation of high pressure phases (coesite, stishovite), indicate that a special transition occurs here during passage of the shock wave instead of simple fusion [3, 7, 8]. V. S. Sobolev assumes that this special transition to a radioamorphous state may be analogous to metamict decay under the action of radioactive α-radiation. Natural metamict minerals are known to be radioamorphous and, probably, are subdispersed aggregates with a particle size of 30 to 60 Å, formed through disintegration of crystalline matter without its external form being modified [9-11]. This subdispersed state is detectable only on an electron diffractometer when waves with a length of about 0.06 Å are employed. In many cases the final result is dissociation into constituent oxides [9-12]. Scientists now envisage this dissociation as being due to the shift of ions (principally with covalent bonds) under the action of α-particles and, in part, to radioactive oxidation.

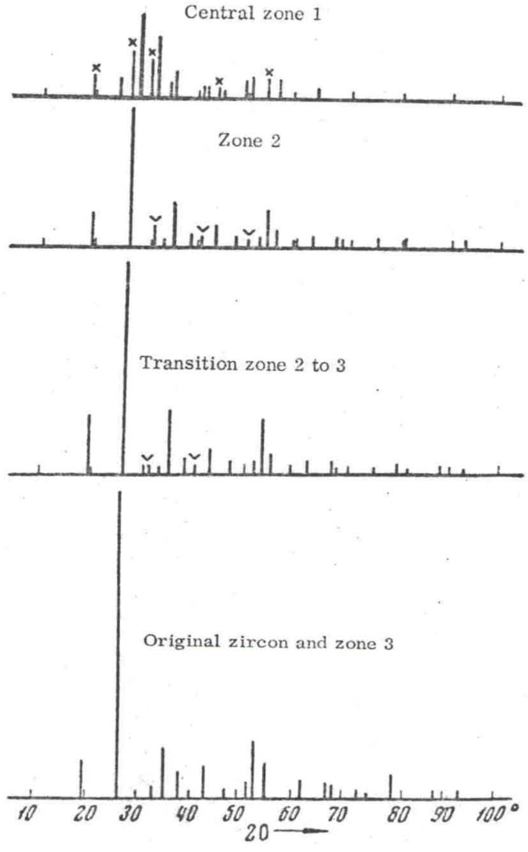

Fig. 1. Diffractograms for different zones of an ampoule with pressed zircon powder. In zones 2 and 2 to 3 ticks mark ZrO_2 lines, while in zone 1 crosses represent principal lines of the metamict zircon of [18] (No. 732 v). Test No. 2

To verify experimentally the assumption about the analogy with metamict decay and determine the essence of the vitreous transition, we selected zircon ($ZrSiO_4$) as the object of our tests since it is one of the most common natural

[1]Translated from: Udarnoye szhatiye $ZrSiO_4$ i metamiktnyy raspad. Doklady Akademii Nauk SSSR, 1968, Vol. 182, No. 4, pp. 910-913.